



Imagining Case Studies

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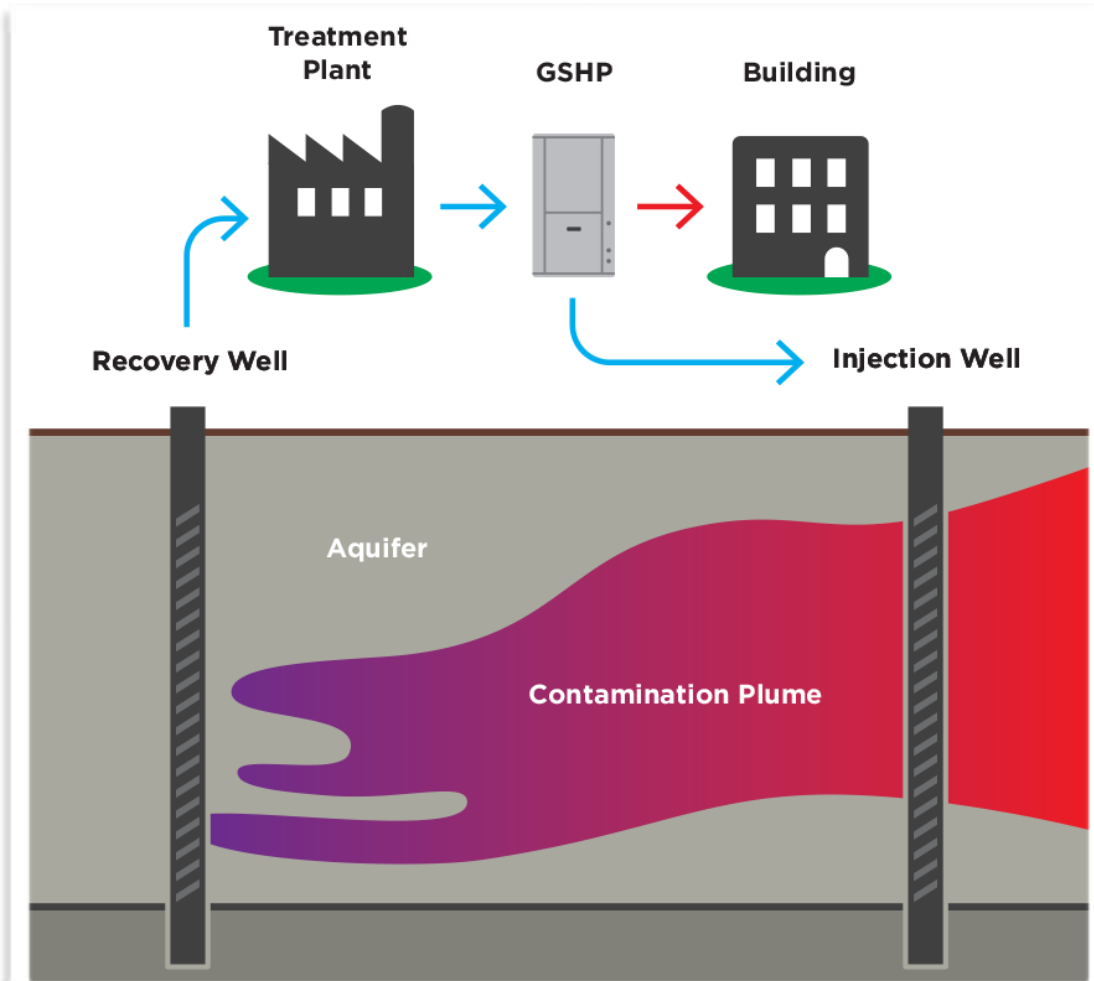


P&T or Bio Enhancement

- Can changing the soil/groundwater temperature enhance remediation?
- Can we potentially change limiting factors such as microbial activity, NAPL viscosity and vapor pressure?



GSHPs with Pump and Treat





GSHPs with Pump and Treat

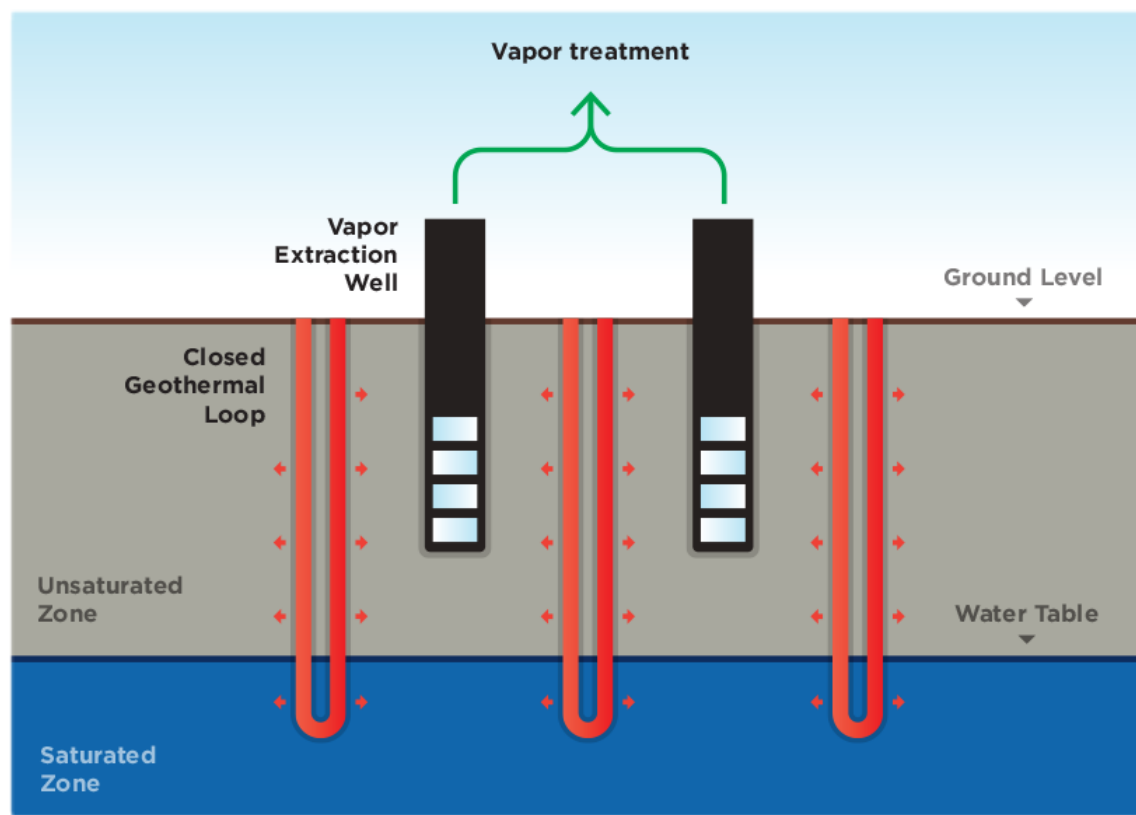
- A 10 C increase in temperature doubles microbial activity, decreases NAPL viscosity and increases VOC vapor pressure.
- For 10 GPM flow a 10 C increase requires ~93,000 BTU
- $5,160 \text{ pounds/hr} * 18 \text{ F} = 92,880 \text{ BTU}$
- Warming the soil around the infiltration area requires additional capacity due to advection and dispersion of heat. How much more heat depends on variables such as soil type, moisture, infiltration, groundwater effects and the size of the desired area of impact.
- Pilot testing could be quite helpful.



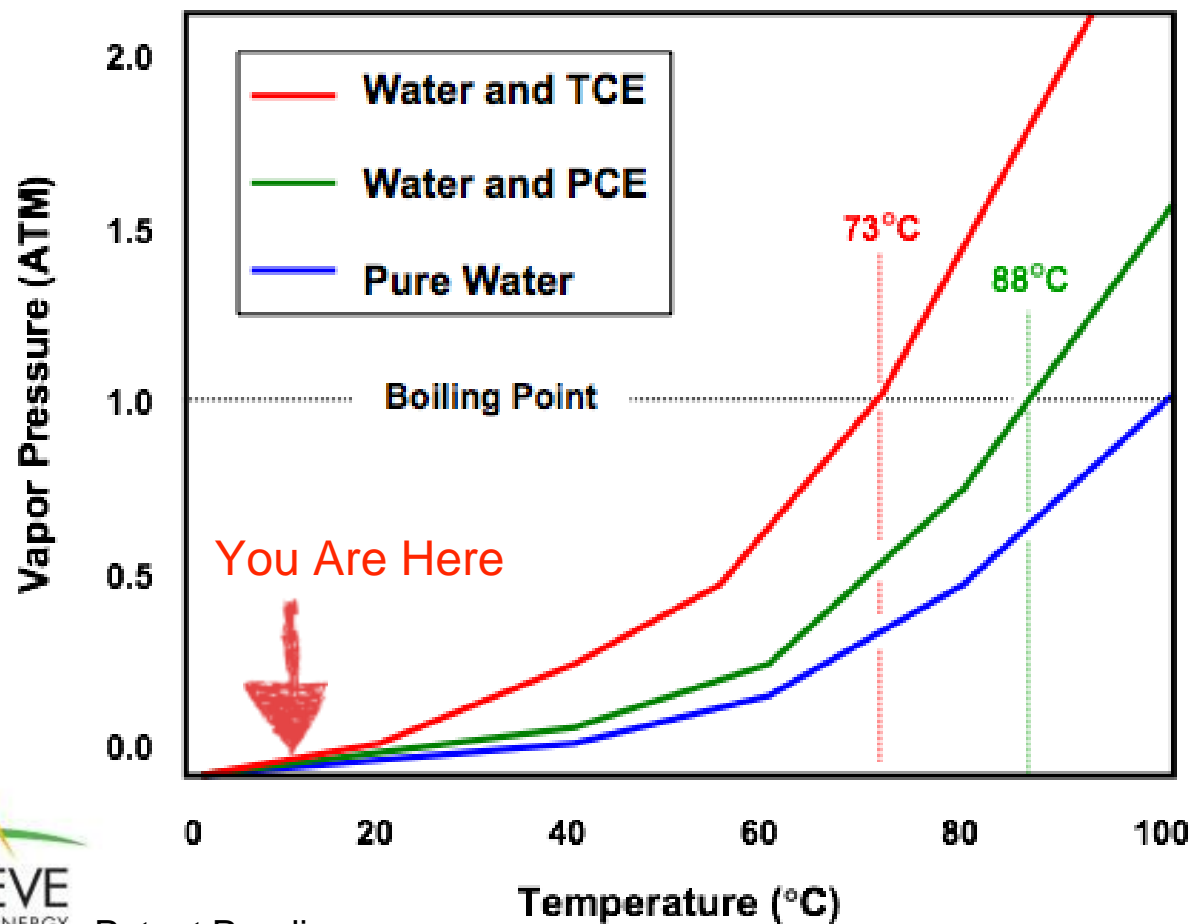
GSHPs with Pump and Treat

- 93,000 BTU is 7.75 tons.
- Given subsurface variance, might start design assuming a 15-20 ton GSHP if an adequate source is available.
- Remember that there are constant flow and water quality issues to consider.
- Also, you need a source from which the GSHP can draw heat.
 - Separate ground-source that could be used after remediation
 - If available a heat source on-Site could be utilized
- Telemetry could be helpful.

SVE with GSHP Heating



Changing Volatilization Rate



Pure TCE
B.P. = 87°C

Pure PCE
B.P. = 121°C



SVE Enhancement

- At 10 C/50 F, TCE+water vapor pressure on chart is less than 0.1.
- At about 40 C/100 F. TCE+water vapor pressure increases to about 0.3 — about triple the lower temperature.



SVE Enhancement

- COP of electric or fossil fuel heating is 1 or less.
- COP of GHSP is 3-4 or more.
- For an equal amount of heating, GSHP requires one-third to one-quarter the energy of electric resistance.
- Benefit-cost analysis of delta-T of 'traditional' heating v. GSHP heating given the fuel and GHG savings is warranted.
- Loop in remedial area could be intentionally designed 'too small' to enhance effects.



Financial Impact of Using GSHPs



Incentives

- Brownfields Tax Credit
- Federal Investment Tax Credit for GSHP
- 5-Year Accelerated Depreciation (MACRS) for GSHP
- Thermal RECs (T-Rex?) - In Massachusetts, AECs can be earned for Remedial Heating.
- Super-efficient heating or cooling available during or after remediation

Impact on SVE System Net Cost

Task	Base Cost	Incentive	Incentive Value	Cost w/GSHP+ Incentives
Trenching	\$80,000	•10% ITC •MACRS	\$8,000 \$26,400	\$45,600
Equipment Installation	\$150,000	BTC?	TBD	\$150,000
GSHP Installation	n/a	•10% ITC •MACRS	\$15,000 \$49,500 ((\$150,000 pre-incentive))	\$85,500
O&M	\$160,000 (\$40,000/yr. x 4 yrs)	•T-Recs •O&M Reduced to 3 yrs.	•\$15,000/yr AECs •\$40,000/yr O&M (10 tons continuous and \$15/AEC)	\$75,000 (AECs could continue for total of 10 years)
Total:	\$390,000			\$356,100 (9% reduction)



Questions?

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